in diameter, and varying in altitude from 1,267 to 1,745 meters, the highest point being on the north. The inward slope of the wall, probably much decreased by fragmental materials from later eruptions, leads by a gentle declivity to a caldera floor about 1,400 meters in altitude on the north but less on the south. The later engulfment produced a smaller circular caldera, 7 kilometers in diameter, in the floor of the earlier one; steep walls, 200 or 300 meters high and more or less ravined, separate the two. So much as now remains of the earlier floor, or Kintamani terrace, is of over-crescentic, or horseshoe, form, narrowest southwards, as the later caldera is somewhat excentric with relation to the earlier one.

Several good-sized cones were built after the breaking down of the original volcano. One of the earlier is Gunung Abang, which surmounts the western side of the main ring wall with a summit of 2,152 meters; its western slope is moderately ravined; its eastern side was broken down by the later sinking of the deeper caldera floor. Important later eruptions produced the confluent cones of Gunung Batur proper, consisting partly of lavas but more largely of fragmental materials, in the center of the later caldera: the higher cone to the north is 1,717 meters in altitude, the lower one, 1,589 meters; each cone has a crater, and each crater wall is highest on the north. The latest lava flow came from the lower cone in 1905 and now covers a southeastern part of the lower caldera floor; but a larger part of the floor, between the central Batur cones and the Abang halfcone on the west is occupied by a crescentic lake of deep blue or green color, which adds greatly to the beauty of the view from the ring wall and makes it one of the finest volcanic panoramas in the Archipelago. The lake surface is about 7 kilometers long by 2.5 kilometers wide and has an area of 15.5 square kilometers. The water is fresh although the lake has no visible outlet; its level rises somewhat during the southwest monsoon. Hot springs occur near the lake and are reported to be of medicinal value. The Batur cones are barren, but the caldera floor and rim wall have more or less vegetation and are in part populated and cultivated.

W. M. Davis

Land Forms of Northwestern Sumatra

W. F. F. Oppenoorth and J. Zwierzycki. **Geomorfologische en tektonische waarnemingen als bijdrage tot verklaring van de landschapsvormen van Noord-Sumatra.** Map, diagrs., ills. *Jaarboek van het Mijnwezen in Nederl. Oost-Indië*, Vol. 46, 1917, Part I, pp. 276–311. Batavia.

This essay is a by-product of governmental geological surveys in Atjeh, the northwesternmost province of Sumatra. The province is 370 kilometers long, northwest-southeast, and about 100 kilometers across, with a full-length coast to the southwest, a somewhat shorter east-west coast that truncates the end of the great island obliquely, and a short northeast coast. The boundary between Atjeh and the adjoining province runs irregularly a little east of north. The essay gives gratifying evidence that modern methods of physiographic analysis are applied by competent investigators in the Dutch East Indies in a thoroughly appreciative manner. Three subdivisions of the province are recognized: (1) The high mountains of the interior, composed of schists and bedded rocks with altitudes of from 1,400 to 2,800 meters and continued southeastward; (2) a bordering hilly belt of variable width, composed of more or less folded sedimentary strata, generally of small resistance; and (3) a low and narrow coastal plain. Volcanic features are irregularly distributed over the three subdivisions.

The late mature or aging forms of a former cycle of erosion are preserved in the highlands in the interior mountains, where rounded summits maintained by the more resistant rocks rise to moderate heights over broad high-level depressions which represent subsequent valleys following belts of weaker rocks; but in consequence of a central upheaval of about 1,000 meters the broad high-level depressions are now incised by deep, early-mature valleys, in which the main rivers are generally graded and have only occasional rapids. Waterfalls are, however, still retained in the upper courses of the side streams, which descend to the main valleys between hilly spurs, the flat tops of which record the present altitude of the former broad valley floors. The upheaval of the region decreases outwards from the central mountains, for the hilly belt has altitudes of only 400 meters next to the mountains and of about 50 meters near the coast. This movement increased the size of the original island by adding some of the adjoining sea bottom to it, especially on the northeast where the added belt is broadest and uninterrupted; it is narrowest on the southwest, where some of the mountains reach the coast in bold headlands. The strata of the hilly belt are chiefly clays

and marls, with occasional conglomerates; they are most folded and most eroded near the mountains, where subsequent valleys are developed along certain anticlinal axes; they are less folded and eroded near the coast, where structural arches and troughs are still expressed in the topography although the arches are well dissected by consequent streams and are cut across in antecedent fashion by the large rivers from the interior. The folded structure has been carefully studied, as some of these strata bear petroleum. Occasional hard beds form cuestas and ridges, but the strata are usually so weak as not to exhibit their folded structure in their surface forms. Here the soils creep and slide so readily down the slopes, especially in cleared districts and at times of heavy rains, that many valley floors are unevenly aggraded and converted into morasses, in which the streams are broken up and confused with the ground water; such valley floors are used for rice culture. The larger valleys, in the mountains as well as in the surrounding hilly belt, exhibit along most of their length the effects of intermittent upheaval in well-defined but discontinuous terraces at two levels; the higher one from 90 to 120 meters, the lower one from 30 to 50 meters, over the rivers. Corresponding wave-cut terraces and wave-built beaches, associated with coral-reef patches and shell deposits, are seen along the outer slope of the hilly belt at heights of 100 and of 40 meters: the coral-reef patches grow up from gravel beds. Low terraces in the main valleys are attributed not to a revival of erosion in consequence of recent uplift but to river floods, although some of the rivers are still deepening their beds. The low coastal plain is from 3 to 30 kilometers wide and from 10 to 15 meters above sea level at its inner border; it is here and there extended by the growing deltas of the larger rivers and by the growing marshes of lagoons enclosed by offshore sand reefs.

Volcanic activity, long continued, has intermittently and unsystematically superposed various features upon the forms above described. Several great cones have been formed in the different areas; one of the largest, Geureudong, is a complex mass which rises over the interior mountains inland from the mid-length of the northern coast; it is broadly truncated at an altitude of 3,260 meters (as if it contained an extensive crater); one of its lateral cones bars the upper course of a river and thus forms Laut Tawar lake, formerly larger than now, but still some 25 kilometers in length. A similar lake in another valley, now drained, is recorded in shore terraces and deltas. Extensive mudflows of volcanic agglomerates and tuffs, from 10 to 50 kilometers in length, bury parts of the hilly belt or flood its valleys, thus more or less completely extinguishing its relief; but these flows are now dissected by narrow, steep-walled ravines with cascading streams. One of the volcanic cones forms the island of We, about 10 kilometers in diameter and 730 meters in height, near the northwestern extremity of Atjeh; it is described in a special article by Zwierzycki (*Jaarboek van het Mijnwezen*, Vol. 45, 1916, pp. 1–11) as of well-dissected form, bearing three wave-cut benches, at 20, 40, and over 100 meters above sea level; the middle bench is the most distinct; it girdles the island and sometimes has a width of 150 meters. Remains of "coral banks" are found on each bench.

The photographic illustrations of the essay on Atjeh are fair; the outline figures in the text might be much better. The physiographic analysis bears every mark of accuracy; but, as it is the work of geologists, it is naturally given a geological phrasing which is avoided as far as possible in the above abstract.

W. M. Davis

Climate and Weather of the Philippines

José Coronas. **The Climate and Weather of the Philippines, 1903 to 1918.** 195 pp.; maps, diagrs. The Government of the Philippine Islands, Philippine Census, A. D. 1918. Bureau of Printing, Manila, 1920. 9 x 6 inches.

Several important studies of the climate of the Philippines have been issued during the past two decades. An extended discussion entitled "Climatología de Filipinas" (1899) was published as a part of "El Archipiélago Filipino," printed in Washington at the expense of the United States Government. An English translation appeared in Volume 4 of the Report of the First Philippine Commission to the President (1901, pp. 113–357). A summary was published in 1900 under the title "Interesting Climatological Data Concerning the Weather of Manila." To the 1903 Census of the Philippines, Rev. José Algué, S.J., Director of the Weather Bureau, contributed another report on climate, which included many of the illustrations and tables of the monograph embodied in "El Archipiélago Filipino," but revised to date. To Father Algué we are also indebted for two pamphlets on the climate of Baguio (1902, 1909). The rainfall has been discussed by Rev. Miguel Saderra